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subjects will be found for whom stimuli of suitable strength would quicken the rate of the Traube-Hering wave, is not unlikely. Only simultaneous records of attention and Traube-Hering waves can decide this point.

The similarity in the diurnal variation and the close approximation in length of the two sorts of waves in three subjects, in spite of the different times at which the two investigations were carried on, make very strongly for the common physiological basis of the processes.

VIII. THE EFFECTS OF CLOSING THE EYES UPON THE FLUCTUATIONS OF THE ATTENTION.

By BERTHA KILLEN.

Münsterberg's peripheral theory takes the stand that the fluctuations of the attention are due to the fatigue and recovery of the accommodation mechanisms in the sense organ. He made a number of elaborately varied experiments upon the sense of sight. His method of experimentation was to fixate the gray rings of the Masson disk and record the fluctuations in series upon a white kymograph drum by means of a tambour and pencil. The general average of the normal fluctuations was first established at 6.9 seconds. He then varied his experiments by use of a "*prismatische lorgnnett*" by means of which the field of vision was moved slightly to the side, requiring a quick movement of the eyes in order to keep the fixation continuous. In case the prisms were held continuously before the eyes, no very great change in the fluctuations would appear. But when the glass was interposed at intervals of two seconds it was found that the fluctuations could be lengthened from 11 to 14 seconds. In the next series, a sound was made by an assistant, every second, which caused the subject to close the eyes quickly for a moment, making a scarcely noticeable break in the fixation. Under these circumstances a decrease to entire vanishing never took place. But when the disk was covered at intervals by a screen the fluctuations went on unhindered.

In view of the fact that Pace recently used these results as a proof of the peripheral or retinal origin of the attention waves, it seemed worth while to repeat them to test their accuracy. Münsterberg argues from these results that the momentary rest permitted the eyes to recover from fatigue.

The subjects were Miss Udell (U.), Miss Barnes (B.), and Mr. Wright (W.), all research students in psychology and were careful, experienced subjects.

The experiments were carried on from September to February, 1903-04. In the case of U. and B. a normal and a modified

record were taken once a week at the same hour; with W., a normal was taken once a week Tuesday or Thursday and a modified record each Tuesday and Thursday, at the same hour.

The manner of experiment was as follows:

The subject fixated a Masson disk which was revolved by an electric motor and showed one dark ring. The subject sat at a uniform distance of about four feet from the desk. To get constant illumination, the disk was placed in a dark room lighted by electricity. A key was pressed at the appearance and released at the disappearance of the ring by the subject's right hand. The make and break were registered electrically on a smoked drum which permits a record of about ten minutes in length to be made. The drum with its motor was placed in a room 100 feet away. The normal record requires no comment. The modified record was taken in the same way with the exception that the eyes were closed every second on the beat of the metronome.

For B. and U. there were 20 normal and 20 modified records each; for W., 20 normal and 40 modified records.

The results vary and differ with each subject. The following are the tables of results:

Average length of period of visibility: .

	B.	U.	W.
Normal,	3.8 sec.	5.4	7.6
Closed Eyes,	4.6	5.6	7.

Average length of period of Invisibility:

	B.	U.	W.
Normal,	3.2	2.8	3.4
Closed Eyes,	4.2	2.4	3.2

Ratio of Invisibility to Visibility. Each record was divided into five parts.

	B.					Ave.
Normal,	.93	1.07	.92	.71	.60	.85
Closed Eyes,	.82	.87	.85	.95	.104	.91
	U.					
Normal,	.71	.47	.48	1.56	.51	.75
Closed Eyes,	.54	.46	.40	.46	.40	.45
	W.					
Normal,	.36	.50	.54	.51	.57	.50
Closed Eyes,	.41	.35	.61	.54	.64	.50

In the case of B., closing the eyes once every second increased the wave of visibility .8 seconds and the period of invisibility one second. With U., the period of visibility was increased two seconds and the record of invisibility decreased .4 seconds. With W., neither the average visibility or invisibility show the increasing tendency. A study of the different stages in the record, however, shows there is a decided

increase in the third period and a slight increase in four and five, it is evident that the voluntary effort first inhibits, then reinforces the perceptive processes. These two influences happen just to cancel each other and the general average is the same for each.

In the case of B., closing the eyes increased the relative efficiency of the attention wave; with U. the effect was a decrease of the efficiency; for W., there was first a decrease then an increase in the efficiency. These individual differences can be explained consistently by the fact of individual differences. Taylor,¹ in his article on "The effect of Certain Stimuli Upon the Attention Wave" has shown that with the same person one stimulus may increase the efficiency of the attention while a stronger would decrease it. In these experiments the stimulus was uniform but would affect different subjects as stronger and weaker. To U., they seemed stronger than to the others.

With W., the proportion of black in the ring was increased until the fluctuations disappeared entirely during the latter part of the record in the closing eyes series. This was found when there was 1/50 part black in the ring. In the normal record the fluctuations still appeared as follows:

Wave of Invisibility 1.8 sec., Visibility 5.2 sec.

The disk used for the other records with W. had 1/75 part black; for U. and B., 1/92 part black.

It would seem, then, that Münsterberg's results are not valid for all people or for all intensities of stimulus or degrees of stimulus differences. What does happen is that there is for certain individuals, probably those of a phlegmatic temperament, a tendency for voluntary effort, as for any stimulus, to reinforce the sensory processes involved in seeing the gray ring, and it chanced that Münsterberg hit upon exactly that intensity of stimulus which could be made supra liminal by the reinforcement. We have been able to hit upon the same intensity for W. For B. we find the same tendency but the stimulus difference was too far below the limen to be made continuously supra liminal. For U., on the other hand, there is a tendency toward decrease of efficiency. It seems very much easier, then, to explain both Münsterberg's results and our own by the central reinforcing than by a peripheral theory.

SUMMARY.

1. Closing the eyes for a moment at regular intervals increases the length of the attention waves and decreases the time of visibility.

2. The slight stimulus of closing the eyes has a tendency to increase the efficiency of the attention waves.

¹*American Jour. of Psy.*, Vol. XII, p. 335.